Course Unit	Engineering of Biotechnological Processes			Field of study	Engeneiring and related techniques		
Master in	Biotechnological Engineering			School	School of Agriculture		
Academic Year	2021/2022	Year of study	1	Level	2-1	ECTS credits	6.0
Type	Semestral	Semester	1	Code	5010-509-1103-00-21		

Workload (hours)	162	Contact hours	T	TP	PL	TC	S	E	OT	O
			30	-	30	-	-	-	4	-

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tutorial; O - Other

Name(s) of lecturer(s): António Manuel Coelho Lino Peres

Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:
1. Recognise the main components of a bioreactor and make their design;
2. Determine mass transfer coefficients to evaluate the aeration system;
3. Know the different operation modes and geometries of a bioreactor;
4. Determine the residence time distributions in order to verify the existence of deviations from ideal reactor behavior;
5. Identify the equations that represent the bioprocesses dynamics;
6. Identify the key state variables that should be monitored during a bioprocess;
7. Distinguish physical sensors and software sensors used for monitoring the main state variables of bioprocesses;
8. Apply control algorithms to maintain the state variables of the process nearby pre-established reference values.

Prerequisites

Before the course unit the learner is expected to be able to:
Integral and differential calculus. Basic concepts of Reaction Engineering and Bioreactors

Course contents

Main components of a bioreactor and their design; Oxygen transfer coefficients; Operation modes and geometry types most commonly used; Selection of the most appropriate biological reactor; Residence time distributions; Equations that represent the bioprocesses dynamics; Main state variables that should be monitored during a bioprocess; Physical sensors and software sensors used for monitoring the main state variables of bioprocesses; Control algorithms.

Course contents (extended version)

1. Design and construction of industrial fermenters:
   - Determination of the volume, geometry and material of construction;
   - Agitation and aeration systems – determination of mass transfer coefficient - KLa;
2. Geometries and Operating Modes of Fermenters:
   - Geometry-type Ex. fixed-bed and fluidized-bed reactors, bubble column reactor, air-lift reactor;
   - Operating modes;
3. Selection of the most appropriated biological reactor;
   - Bioreactor versus chemical reactors. Key issues in bioreactor design and operation.
   - Fermentation technologies
   - Other: Product concentration/purity Degree of substrate conversion Separation/purification processes
4. Non-ideal behavior of reactors: Residence time distributions and how to predict them.
   - Characterization and diagnostics
   - Residence-time distribution (RTD) function Measurement of RTD and its characteristics
   - RTD in Ideal reactors
   - Non-ideal reactors
5. Instrumentation and control of biological reactors.
   - Parameters: to be monitored/controlled: Temperature, Pressure, Agitator power, Flowrate, pH, DO, etc
   - Type of sensors
   - Control systems (e. g. , Feedback Control Loop, automatic control loop)

Recommended reading

1. Stanbury, P. F. ; Whitaker, A. ; Hall, S. J. 1995, “Principles of Fermentation Technology”, 2nd Edition, Elsevier Science Ltd. (ISBN 0-7506-4501-6);
2. Shuler, M. L. ; Kargi, F. 2001, “Bioprocess Engineering: Basic Concepts”, 2nd Edition, Prentice Hall (ISBN 978-0130819086).
3. Bailey, J. E. and Ollis, D. F. , 1987, “Biochemical Engineering Fundamentals”, McGraw-Hill (ISBN 978-0070032125);
4. Fonseca, M. M. e Teixeira, J. A. , 2007, “Reactores Biológicos: Fundamentos e Aplicações”, Lidel (ISBN 978-9727573660).
5. Fogler, H. S. , 2011, "Elements of Chemical Reaction Engineering", Prentice Hall (ISBN-13: 978-0-13-714612-3)

Teaching and learning methods

Theoretical classes: the theoretical concepts will be presented. Theoretical and practical classes: it is intended to solve exercises related to the topics addressed in the discipline; Laboratory classes: experiments will be undertaken in the laboratory to address the determination of yields, oxygen transfer coefficients and fermentations in batch mode.

Assessment methods

1. Exame - (Student Worker) (Final, Supplementary, Special)
   - Final Written Exam - 100%
2. Continuous evaluation - (Regular, Student Worker) (Final)
   - Final Written Exam - 80%
   - Practical Work - 20% (Works presented by the students.)

Language of instruction

1. English
2. Portuguese

Electronic validation

António Manuel Coelho Lino Peres	Maria da Conceição Constantino Fernandes	Paula Cristina Azevedo Rodrigues	Elsa Cristina Dantas Ramalhosa
26-11-2021	05-12-2021	05-12-2021	06-12-2021